Four – to Three-lane Road Diet Conversion

The recommended bicycle network for Wichita includes a number of roadways where a four – to three – lane "road diet" conversion is recommended in order to provide roadway space for bicycle lanes. The resulting cross section of recommended road diets would include two vehicle travel lanes plus a center left-turn lane and a bicycle lane on both sides of the roadway. As a result, buses operating in these corridors would stop in-lane when boarding and alighting passengers, possibly causing delay for other vehicles. This memo is intended to provide information on the factors that help determine when bus operations may negatively impact motor vehicle travel speeds.

Recommendations

The factors listed below for consideration of bus turnouts may be used as guidance for determining when bus operations could result in significant impacts to roadway travel speeds in a four- to three-lane conversion scenario. Recommendations in this Plan represent a conservative application of these factors. Corridors where the following transit-related factors are present should be considered for a 4 – to 3-lane conversion:

- Traffic speeds are 35 mph or less
- Bus volumes are 6 or less per hour
- Average peak hour dwell times are less than 30 seconds per bus.
- Passenger volumes are less than 30 boardings an hour

Bus Operations and Effects on Travel Speeds

Research indicates that the presence of heavy vehicles and frequent stop/slower moving vehicles such as busescan result in slower vehicle travel speeds on three-lane cross-sections versus four-lane cross sections.[1]The degree to which vehicles such as buses, which stop frequently, affect travel speeds of other vehiclesis a function of traffic volumes and the percent of volume that buses represent in the overall mix of traffic. Using model simulations of two road conversion projects, it was found that approximately 50 percent of the speed reduction occurred at and above 20 percent heavy vehicles for a roadway with volumes of 750 vphpd.[2] These findings indicate that where the volume of buses is low, the impact of bus operations on the travel speeds of other vehicles will be less. Research that specifically addresses the impacts of bus operation factors such as number and spacing of stops, headways, and dwell times on travel speeds on 3-lane roadways is not available.

Bus Turnouts

Bus bays or turnouts may help to reduce travel speed impacts associated with stopped buses. Bus bays are provided primarily on high-volume or high-speed roadways, such as suburban arterial roads. Additionally, bus bays are frequently constructed in heavily congested downtown and shopping areas where large numbers of passengers may board and alight. Turnouts can be in the form of wider parking lanes or separate bus only areas outside of the travel way. The ability to provide bus turnouts is contingent upon available right-of-way or the ability to remove on-street parking. Bus turnouts should be considered where feasible as part of an overall road diet design. Report 19 of the Transit Cooperative Research Program (TCRP) provides guidelines for the location and design of bus stops, including when

[1] Knapp, Keith, K. Giese and Woochul Lee, *Urban Four-Lane Undivided to Three-Lane Conversion Guidelines*, August 2003.

[2] Knapp, Keith, K. Giese and Woochul Lee, Urban *Minor Arterial Four-lane Undivided to Three-Lane Conversion Feasibility: An Update*, July 2003.

turnouts should be considered. The report suggests a number of factors that should be used to determine when turnouts should be considered. For Wichita, the most critical among these factors are:[3]

- Traffic speed exceeds 40 mph
- Bus volumes exceed 10 in the peak hour
- Passenger boardings exceed 20-40 per hour
- Average peak hour dwell time exceeds 30 seconds per bus

While one or more of these criteria may be met on any given roadway, best engineering judgment is needed to determine the potential travel speed impacts, and whether or not a bus turnout is the most appropriate treatment for mitigating these impacts.

One critical caveat is the authors of the TCRP Report determined the quantity of traffic in the curb lane created a limitation on the effectiveness of separate turn outs (or bus bay) finding:
"Evidence shows that bus drivers will not use a bus bay when traffic volumes exceed 1000 vehicles per hour per lane. Drivers explain that the heavy volumes make it extremely difficult to maneuver a bus out of a midblock or near-side bay, and that the bus must wait an unacceptable period of time to re-enter the travel lane. Consideration should be given to these concerns when contemplating the design of a bay on a high-volume road. Using acceleration lanes, signal priority, or far-side (versus near-side or midblock) placements are potential solutions[4]."

Figure 1 - Example of Lane Blocking By Bus Operator

The report indicated a preferred curbside lane width for bus turnouts to be 10-12 feet separate from traffic.

2011 AASHTO Green Book
The 2011 AASHTO Green Book provides general guidance for vehicle lane widths and discusses considerations for bus operation on arterial roadways in urban areas. The AASHTO Green Book generally provides design strategies to minimize delay and disruption to traffic flow. The Green Book generally recommends the installation of bus turn outs with acceleration/deceleration lanes to minimize the disruption of traffic flow, but recognizes this is rarely possible on urban arterial roadways.

The Green Book also recognizes the challenges of constrained urban roadways noting that bus operation creates interference with other traffic when the bus stops within the travel lane[5]. It specifically notes "bus operators may not use the turnout if they have difficulty maneuvering back into traffic." Other than suggesting the use of far side stops to minimize conflicts with turning vehicles and accommodate large demand for vehicle storage on near-side approach, the Green Book provides no additional guidance for bus stop design and refers the reader to TCRP Report 19 referenced previously.

[3] TCRP Report 19, page 27. Only the factors most relevant to Boston roadway operations are listed here.
[4] TCRP Report 19, page 27
[5] Page 500, 2004 AASHTO Green Book